Progress Report,

SEEDS LOS/CE Study
(Levels of Service / Cost Estimation)

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Agenda

Objective:

Present progress to date on the LOS/CE Study, including a brief walk-through of how the model will work.

Comments on the process of cost by analogy, data for the cost model, and any other aspect of the work will be most welcome.

Topics:

1. **Follow-Up to February 2002 Community Workshop**
2. **Status of Model Development**
3. **Use Case Scenarios – Walkthrough for First Prototype**
4. **Data Collection and the Comparables Database**
5. **Investigation of COTS Cost Estimation Tools**
6. **Progress toward Demonstration Prototype**

Follow-Up to February 2002 Community Workshop (1)

- **The first SEEDS public workshop focused on establishing levels of service for SEEDS providers**
- **Goals:**
  - **Work with data service providers and end users to identify baseline levels of service needed from SEEDS era data service providers.**
    - **Focused on levels of service needed from peer data provider/users**
    - **Determine appropriate breakout of LOS by science discipline**
  - **Garner community support for proposed process leading to development of a SEEDS cost model and cost estimation tools.**
    - **Obtain feedback on Cost Team white paper (distributed to attendees ahead of the workshop) to refine the study approach, cost model parameters.**

Follow-Up to February 2002 Community Workshop (2)

- **Fifteen white papers were provided at the February Workshop, of which eight were directly relevant to the LOS/CE study.**
- **Comments were obtained from breakout session chair notes and the LOS/CE team's own notes.**
- **Feedback including a total of 40 recommendations were distilled from these sources (next charts).**
- **There was very little if any inconsistency in the recommendations, making it possible to accept and act (to some degree) on them all.**
- **The original January 16, 2002 LOS/CE White Paper has been divided into a set of seven LOS/CE Working Papers, six of which have been posted to the SEEDS website – review and comment are welcome.**
- **The content of the six Working Papers reflect the recommendations and comments received at the February Community Workshop.**
- **Ongoing work (to be discussed later) will reflect Workshop results.**

Key Feedback from Workshop

- **Cost model needs to emphasize flexibility in groupings of functionality into physical entities.**
  - **One size doesn't fit all – neither does seven.**

    (WP-6 clarifies that the seven logical types are an open set.)
  - **Consider use of pull down menus of functions to be "priced".**

    (Accepted, WP-2 and scenario in coming charts reflects this.)
  - **Logical differentiation between mission data centers, science data centers, and backbone data centers was not evident.**

    (Clarified in WP-6)
- **Need to separate data search and ordering functions from distribution.**
  - **Likely that "search and order" service could be separated from the actual data management.**

    (Done, as shown in WP-3's 3, 4, 5)

Key Feedback from Workshop (2)

- **Need to consider need for highly educated, discipline expertise at the data service centers. Cost for these experts may not be included in commercial cost model.**

  (Done – added as distinct items in model, reflected in WP-4, 5)
- **Ensure that the cost model allows for subcontracting of functionality – perhaps to commercial firms.**

  (Taken as an item to be done in the future.)
- **Reexamine description of the "applications center" logical type.**

  (The "Applications Center" section in WP-6 was redone, drawing on workshop comments and especially the new ESE Applications Strategy document.)

Key Feedback from Workshop (3)

- **Alternate methods for getting additional feedback on SEEDS from user community were suggested:**
  - **Take the message directly to the users by talking to DAAC UWGs, ESIP advisory groups, etc.**
  - **Interview individual users – have DAACs and ESIPS recommend users to be contacted.**
  - **Hold focus groups on LOS, sessions on LOS at science conferences.**
  - **Employ data providers, especially user support staff (e.g. DAAC USWG) as proxies for their end users.**
  - **Encourage end users and data providers to visit the SEEDS website and leave comments.**

  (All are being done at some level…spoke to 3 DAAC UWGs and invited them to this conference…in contact with ESIPs via study team and Federation Meetings…attending conference in Toulouse this fall concerning cost modeling.)
- **Consider using scenarios of what types of activities will be on-going in SEEDS, then look at appropriate approaches to meeting the scenarios, and ensure that cost model can provide estimates of costs for them.**

  (*Contained in Barkstrom's model and to some extent in cost by analogy model.)*
- **At the appropriate time, enlist the help of "tire-kickers" to independently evaluate the cost model.**

  (This will be done, beginning as early as possible in the prototype cycle, and continuing for the life of the project.)

LOS/CE Working Papers, updated per Feedback

Now available for review and comment on SEEDS website:

Working Paper 1 – Project Overview and Technical Approach

Working Paper 2 – Cost Estimation by Analogy Model

- **Includes use case scenarios for PI/Project and ESE Program Level**

Working Paper 3 – Data Service Provider (DSP) Reference Model – Functional Areas

- **Refined per February Workshop recommendations**

Working Paper 4 – DSP Reference Model – Model Parameters

- **Updated per changes to WP-3 and WP-5**

Working Paper 5 – DSP Reference Model – Requirements / Levels of Service

- **Refined per February Workshop recommendations**
- **Added User-Oriented View of services**

Working Paper 6 – ESE Logical Data Service Provider Types

- **Emphasized logical, not physical, nature of types – functional groupings**
- **Updated per Workshop Breakout discussions, etc.**

Status of Model Development

Three facets of model development:

DSP Reference Model, Cost By Analogy Model, Comparables Database

DSP Reference Model is the Underpinning:

Functional Areas – Requirements/Levels of Service – Parameters

Includes and Organizes all Parameters used by Cost-by-Analogy Model and Comparables Database

Current Status:

DSP Reference Model:

Working definition in hand, updated per February workshop recommendations (WP-3, WP-5, WP-4).

Cost by Analogy Model:

Use Case Scenarios (next chart) developed, consistent with Workshop recommendations.

Initial 'Parameter Matrix' that outlines relationships between parameters [input-process-output chains] completed, with CERs TBD for now. (Available on request.)

Comparables Database (CDB):

Initial Schema / Template defined, data from sites being compiled into first records of CDB.

Use Case Scenarios

Three use case scenarios for the cost estimation capability have been developed:

1. Use by a principal investigator (PI) to develop a life cycle cost estimate for a new data activity as part of a proposal responding to a NASA AO for a flight project or research effort.

2. Use by a data center (DAAC, ESIP, etc.) to develop as life cycle cost estimate for adding a new data activity to an existing base, to respond to a NASA AO or to a PI seeking data management support.

3. Use by an ESE program official engaged in a comparative analysis of alternative ESE data service architectures.

These scenarios will be used to guide development of cost estimation model prototypes. They will be refined, extended, added to as needed based on community feedback / evaluation of prototypes.

The first prototype, Demonstration Prototype, will implement the first use case.

The next charts walk through that scenario, and show how the cost estimation capability will work.

A few sample screens included, Excel worksheet segments – intent is to build Demonstration Prototype as an Excel application.

P.I. Scenario Walkthrough (1)

Producing a life cycle cost estimate for a "data activity":

- **User Enters an "Activity Dataset", which includes:**
  - **Control information (e.g. mission / project start, years of operation).**
  - **Costing Information (e.g. labor rates, inflation rate to assume).**
  - **Selected Functions to be performed by the data activity; some are mandatory, some optional.**
    - **Mandatory: e.g. Ingest, archive (or working storage).**
    - **Optional: e.g. Processing, instrument / mission operations.**
  - **For each function selected:**
    - **Applicable Levels of Service**
    - **Mission Detail (e.g. volume of data to be ingested, produced, archived, distributed)**
- **User can start fresh to build a new activity dataset, can name and save activity data sets, can recall a saved activity dataset and modify it (e.g. to examine trade-off possibilities).**

The "active activity dataset" is at any time the one that the user is in the process of building, modifying, or producing an estimate from.

P.I. Scenario Walkthrough (2)

Assume that a new flight project or research effort is being proposed in response to a NASA Announcement of Opportunity (AO) or other solicitation vehicle.

The group developing the proposal examines its need for data management support - i.e. decides what functions it requires and what service needs it has for each (including what levels of service it needs).

The group puts together an activity dataset, a description of its mission requirements for data management support - e.g. best quantitative estimates of what data will be received, produced, distributed (details sensor and ancillary data streams, products to be generated, distribution to team members or other users) etc.

The cost estimation tool assists the user in preparing its activity dataset by providing a checklist of information required for the mandatory functions and any optional functions selected by the group, and control and costing information.

The next sequence of charts will state the scenario, adapted from the one in WP-2 and interpolate some draft 'screens' that illustrate what the user would see.

The scenario is presented as a sequence of steps, each consisting of a user action and a cost estimation tool response. The scenario is presented in four parts:

- **Preparation for Entry of an Activity Dataset,**
- **New Activity Dataset Entry,**
- **Modified Activity Dataset Entry,**
- **Production of the Estimate.**

Preparation for Entry of an Activity Dataset

User:	Tool:
1. User activates Tool.	1. The tool asks if the user wishes to prepare to enter a new activity dataset, or enter a new activity dataset, or modify an existing activity dataset, and produce a cost estimate.
2. The user selects ‘prepare to enter a new activity dataset’.	2. The tool displays a checkbox list of mandatory and optional functions (i.e. mandatory shown already checked).
3. The user checks the boxes for the optional functions required by the project.	3. The tool displays a checklist of information required to produce an estimate for a data activity that would perform the mandatory and selected optional functions.

New Activity Dataset Entry (1)

User:

1. User activates the tool.
2. The user selects ‘produce estimate from new activity dataset’.
3. The user enters control and costing parameters.
4. The user selects a function from the menu, or selects “activity data set complete”.

Tool:

1. The tool asks if the user wishes to prepare to enter a new activity dataset, or enter a new activity dataset, or modify an existing activity dataset, and produce a cost estimate.
2. The tool displays an entry form for control and costing parameters. *[Sample Screen 1]*
3. The tool checks the entries, then displays a menu of mandatory and optional functions.
4. A. If function selected, the tool displays forms for the function for entry of needed level of service and mission information. *[Sample Screens 2,3]*

   B. If “activity dataset complete” selected, go to 6 – Tool.

New Activity Dataset Entry (2)

User:

5. **The user enters the level of service and mission information for the function.**

Tool:

5. **The tool checks the entries, and returns to the function menu, step 3 above.**
6. **The tool verifies that all mandatory function forms have been completed, and requests entry of any that are missing. When all have been entered, the tool goes to Production of Estimate.**

Modified Activity Data Set Entry (1)

User:

1. The user activates the tool.
2. The user selects ‘produce estimate from a modified activity dataset’.
3. The user provides the activity dataset name.

Tool:

1. The tool asks if the user wishes to prepare to enter a new activity dataset, or enter a new activity dataset, or modify an existing activity dataset, and produce a cost estimate.
2. The Tool requests the name of the existing activity dataset that is to be modified.
3. A. The tool reads in the existing activity dataset, which now becomes the active activity dataset.

   B. The tool displays an entry form for control and costing parameters, showing the values from the active activity dataset.

Modified Activity Data Set Entry (2)

User:

4. The user modifies the control parameters and costing parameters as desired.
5. The user selects a function from the menu, or selects “activity data set complete” and the scenario proceeds with step 7 – Tool.
6. The user modifies the level of service and mission information for the function as desired.
7. From 5 above.

Tool:

4. The tool checks the entries, and displays a menu of mandatory and optional functions (indicating those for which information exists in the active activity data set).
5. The tool displays forms for the function containing level of service and mission information from the active activity data set.
6. The tool checks the entries, and returns to the function menu, step 4 above.
7. The tool goes to Production of Estimate.

Produce Estimate

User:

1. (user has entered or modified an activity dataset)
2. User selects “produce estimate” or “no”.
3. (user has produced estimate or skipped doing so)
4. The user provides a name for the activity dataset (including the estimate), or declines to save it.
5. The user indicates ‘yes’ or ‘no, exit the tool’.

Tool:

1. The tool asks the user if he/she wishes to produce an estimate.
2. A. If the user selected “no”, the tool goes to step 3 below.

   B. If the user selected “produce estimate”, the tool executes and produces the estimate for the active activity dataset. *[Sample Screen 4]*
3. The tool asks if the user wishes to name and save the active activity dataset, including the estimate if produced.
4. The tool saves the active activity dataset, asks the user if another estimate is to be produced.
5. A. If the user has indicated “yes”, the tool goes to “Modified Activity Dataset Entry” step 3b.

   B. If the user has indicated “no, exit the tool”, the tool exits.

Draft Sample Screens

- **The next charts contain drafts of sample screens that the user would see in the course of working through the scenario.**
- **These are Excel worksheet segments – current intent is to build demonstration prototype as an Excel application, using Excel's visual basic feature.**
- **Sample screens included:**
  - **1 – Control and Costing Information Entry**
  - **2 – Ingest Function Information Entry**
  - **3 – Processing Function Information Entry**
  - **4 – Cost Estimate Output**

Sample Screen 1 - Control and Costing Information Entry

Enter Control and Costing Information					
Enter Data Activity Name:					
Enter Mission / Project Start Year:					
Enter Operations Start Year:					
Enter Operations Complete Year:					
Enter Loaded Labor Rates below,	(as of Mission / Project Start Year)				
Management Staff Labor Rate:		K$/Yr	Sustaining Engineering Labor Rate:		K$/Yr
Technical Coordination Staff Labor Rate:		K$/Yr	Engineering Support Labor Rate:		K$/Yr
Development Staff Labor Rate:		K$/Yr	Facility / Infrastructure Labor Rate:		K$/Yr
Operations Staff Labor Rate:		K$/Yr	Enter Annual Inflation Rate:		%

Sample Screen 2 - Ingest Function Information Entry

Ingest Function Information Entry		
Enter the following for each product type or aggregate of types to be ingested:		
Product or Aggregate Name:		Product types with common characteristics may be aggregated
Number of Product types included in Aggregate:		1 - No aggregation used, else number
Source:		Name, or number of sources for aggregate
How Received:		1 - Electronic, 2 - Media
Level of Service:		1 - Time critical ingest with immediate verification of data integrity and quality
		2 - Rountine ingest and verification without tight time constraints
		3 - Ad-hoc or intermittent ingest with verification
		4 - Ad hoc, non-operational ingest
Retention Period, Years:		Number of years, or '0' for indefinite.
Product Format as Ingested:		Format type, e.g. HDF, EOS-HDF, Binary, Native, etc.
Product Format as Stored:		Applicable if products are converted to a different format on ingest.
Products of this type/aggregate ingested per day:		Sum over types for aggregate
Total Volume of this type/aggregate ingested, GB per day:		Sum over types for aggregate
Enter Another Product/Aggregate? (Y or N)		If No, return to Function Menu

Sample Screen 3 - Processing Function Information Entry

Processing (Product Generation) Function Information Entry		
Science Software Level of Service:		1 - Accept operational, research, data mining / integration product S/W
		2 - Accept research, data mining / integration product S/W
		3 - Accept operational and research product S/W
		4 - Accept research product S/W
		5 - Accept operational product S/W
Cross-Calibration:		1 - Explicit mission responsibility, 0 - not.
Enter the following for each product type or aggregate to be produced:		
Product or Aggregate Name:		Product types with common characteristics may be aggregated
Production Start Year:		0 - Match Operations Start Year
Production Stop Year:		0 - Match Operations Complete Year
Science Software Source:		1 - Developed In-House, 2 - Received from Science Team or Other External
Product Quality Assurance:		1 - Performed In-House, 2 - Performed by Science Team or Other External
Production Mode:		1 - Operational, 2 - Non-Operational
Operational Production Mode:		1 - Scheduled/Routine, 2 - On-Demand, 0 - N/A
Operational Level Of Service:		1 - Generate within 2 days, 2 - within 7 days, 3 - within 30 days, 0 - N/A
Non-Operational Level of Service:		1 - Specific target, 2 - General goal, 3 - Purely Ad-Hoc, 0 - N/A
Reprocessing Level of Service:		1 - Scheduled, 2 - General goals, 3 - Time Available, 0 - N/A
Reprocessing Plan / Schedule:		Nominal number of years between reprocessings, or 0 if N/A
Reprocessing Capacity for this Product type/aggregate:		1 - 9 X production rate, 2 - 6 X, 3 - 3 X, 0 - N/A
Retention Period, Years:		Number of years, or '0' for indefinite.
Product Format:		Format type, e.g. HDF, EOS-HDF, Binary, Native, etc.
Products of this product type/aggregate generated per day:		
Total Volume of this type/aggregate generated, GB per day:		
Enter Another Product/Aggregate? (Y or N)		If No, return to Function Menu

Sample Screen 4 - Cost Estimate Output

Life Cycle Cost Estimate for:	Sample-DIS					Produced:	1-Oct-02		
Mission Start Year:	**2003**		**Operations Start Year:**		**2005**		**Mission Complete Year:**		**2011**
Estimated Staffing	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Management Staff FTE	1.25	2.00	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Technical Coordination Staff FTE	0.50	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Development Staff FTE	8.00	8.00	2.50	1.50	1.50	3.00	1.50	1.50	1.50
Operations Staff FTE	0.00	3.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
Sustaining Engineering FTE	0.00	0.00	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Engineering Support FTE	1.00	1.50	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Facility / Infrastructure FTE	1.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
EstimatedTotal FTE	**11.75**	**17.00**	**24.50**	**23.50**	**23.50**	**25.00**	**23.50**	**23.50**	**23.50**
Estimated Staff Costs, K$	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Management Staff Cost	156	258	332	341	352	362	373	384	396
Technical Coordination Staff Cost	75	77	159	164	169	174	179	184	190
Development Staff Cost	960	989	318	197	203	417	215	221	228
Operations Staff Cost	0	309	955	983	1,013	1,043	1,075	1,107	1,140
Sustaining Engineering Staff Cost	0	0	446	459	473	487	502	517	532
Engineering Support Cost	120	185	382	393	405	417	430	443	456
Facility / Infrastructure Staff Cost	100	206	318	328	338	348	358	369	380
Total Estimated Staff Cost, K$	**1,411**	**2,024**	**2,910**	**2,866**	**2,952**	**3,249**	**3,131**	**3,225**	**3,322**
Other Costs, K$	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Hardware Purchase Cost	450	800	200	0	0	500	0	0	0
COTS Software Cost	250	100	100	100	100	100	100	100	100
Facility Preparation / Support Cost	250	100	120	125	130	250	145	150	160
Hardware Maintenance Cost	45	125	128	131	134	180	185	190	195
Network / Communication Cost	25	75	75	70	65	60	55	50	45
Supplies Cost	15	10	50	75	100	105	110	125	130
Total Estimate of Other Costs, K$	**1,035**	**1,210**	**673**	**501**	**529**	**1,195**	**595**	**615**	**630**
Total Estimated Cost, K$	**2,446**	**3,234**	**3,583**	**3,367**	**3,481**	**4,444**	**3,726**	**3,840**	**3,952**

Data Collection and the Comparables Database

Initial letters sent out by email in February to first 20 Data Activities.

Data service providers have been asked for documentation or pointers to documentation containing information needed for the comparables database.

Initial responses received from five Data Activities:

GSFC DAAC, OceanESIP, GRACE, TerraSIP, Nautilus RESAC.

Thank you!

We have been in contact with nine other sites: EDC DAAC, NSIDC, TSDIS, MODAPS, SIESIP, LaRC DAAC, PO.DAAC, GHRC, QuikScat.

Information from a number of data centers was collected for the 2000 Data Center Best Practices and Benchmark Study - will be used as feasible for the comparables database.

A template has been developed (Excel workbook) to capture data from sites, support analysis / mapping to CDB parameters, and development of CDB entry for each data activity.

The first site information is being analyzed and inserted into the template / CDB.

The effort to collect information and build the comparables database will proceed for many months. The near term intent is to get a sufficient sample (about 6) cases complete) to support model development and a demonstration prototype capability by October, 2002.

Investigation of COTS Cost Estimation Tools (1)

COTS Cost Estimation tools are being examined for use in conjunction with the cost estimation by analogy tool being developed.

COTS Tools, e.g. COCOMO based, offer an alternative for estimating development costs:

- **COTS could be used stand-alone to give the cost estimator additional tools to compare results and do 'sanity checks' among several cost estimation programs – consistent with good practice, or,**
- **COTS could be possibly be integrated into cost by analogy tool – especially if testing on independent cases shows a COTS tool to be superior.**

Other COTS Tools may be aids to building the cost by analogy tool, e.g. aid in development of CERs.

Starting with an initial list of 31 COTS programs, several evaluation steps downsized the list to a manageable 3.

Evaluation criteria included cost, ease of use, flexibility, vendor support and other criteria including the selection of different cost estimation methodologies.

Investigation of COTS Cost Estimation Tools (2)

The 3 programs selected for initial evaluation are:

1) **COCOMO II – a well established, open source software parametric cost model that we will examine for software development, reuse, maintenance, and COTS cost estimation**
2) **ModelBuilder/Estimator—also a parametric cost model with a capability to create custom parametric cost models. Methodology very similar and adaptable to what we are doing in SEEDS life cycle analogy cost model.**
3) **NeuroShell Predictor – uses non-parametric, neural network prediction and genetic training algorithms that we feel have promise in isolating and identifying true cost drivers.**

Each of the above programs are being evaluated separately and will be considered for potential integration with the analogy model.

Progress Towards Demonstration Prototype

'Demonstration' prototype planned for October, 2002.

Objectives:

- **Produce a life cycle cost estimates, with whatever simplifications are necessary.**
- **Show how the cost estimation tool will work.**
- **Show how a user will use it.**
- **Show how the Principal Investigator scenario will be realized.**
- **Get review and feedback by the community and ESE.**

The demonstration prototype will:

- **Use a partial, very limited comparables database (about 6 data service providers).**
- **Employ an initial set of simple CERs based on the limited comparables database.**
- **Be a proof-of-concept, though limited database and simple CERs will limit its ability to provide reliable estimates. Future prototypes will be tested against independent cases.**

Initial 'Parameter Matrix' that outlines relationships between parameters [input-process-output chains] completed – CERs TBD for now. (Available on request.)

Background

Levels of Service and Cost Estimation Study Goals

Goal: Develop data service provider levels of service:

- **–Levels of Service (LOS) must be driven by science community – program science, project science, researchers.**
- **–Use a draft set of requirements associated with LOS to support cost estimation; not necessarily requirements to be levied on data service providers by NASA, e.g. they could be similar to requirements owned by the provider.**
- **–LOS and associated requirements will not embody or drive an architecture.**

Goal: Develop a cost estimation model that estimates life cycle costs for data service providers:

- **–Model to be driven by levels of service and requirements;**
- **–Model to support estimating individual data service provider costs and architecture trades.**
- **–To facilitate cost estimation and support architecture trades, develop a set of data service provider types (architecture components) map LOS-requirements set to these.**

Approach

1. Data service provider cost estimation must be grounded on an understanding of baseline levels of service and requirements.

- **Define a set of 'functional areas' that span all significant areas of cost.**
- **Develop a general Data Services Provider Reference Model that relates levels of service / requirements and model parameters (metrics) for the functional areas.**
- **Develop a strawman set of general levels of service / requirements for community review – refine levels of service to a baseline established with the community at this workshop.**
- **Develop a working set of data service provider types – architecture components – map levels of service and associated requirements to these.**

Approach, Continued

2. Use Cost Estimating by Analogy as basic methodology, augment with commercial cost estimating tools.

- **Build database of 'comparables' – existing ESE and other data activities, bin by data service provider type and functionality.**
- **Develop cost estimating relationships through analysis of the comparables data base.**
- **Produce test/prototype data service provider life cycle cost estimates.**
- **Test against independent cases, expand database, revise and improve model. Provide prototype for evaluation, followed by improved versions.**
- **Provide data service provider cost estimates, single and architectures.**
- **Provide a portable capability to enable users to generate their own cost estimates.**

Eight February Workshop White Papers Directly Relevant to LOS/CE Study

1. "User Oriented Services Model", Steve Kempler

2. "SEDAC Inputs to SEEDS Levels of Service Workshop", Bob Chen, Chris Lenhardt

3. "Operational User Support (OUS) Manifesto", Hank Wolf

4. "Distributed Data Access, Analysis, and Standards for Earth Science Data", Menas Kafatos

5. "Outreach, Education Training", Brenda Jones

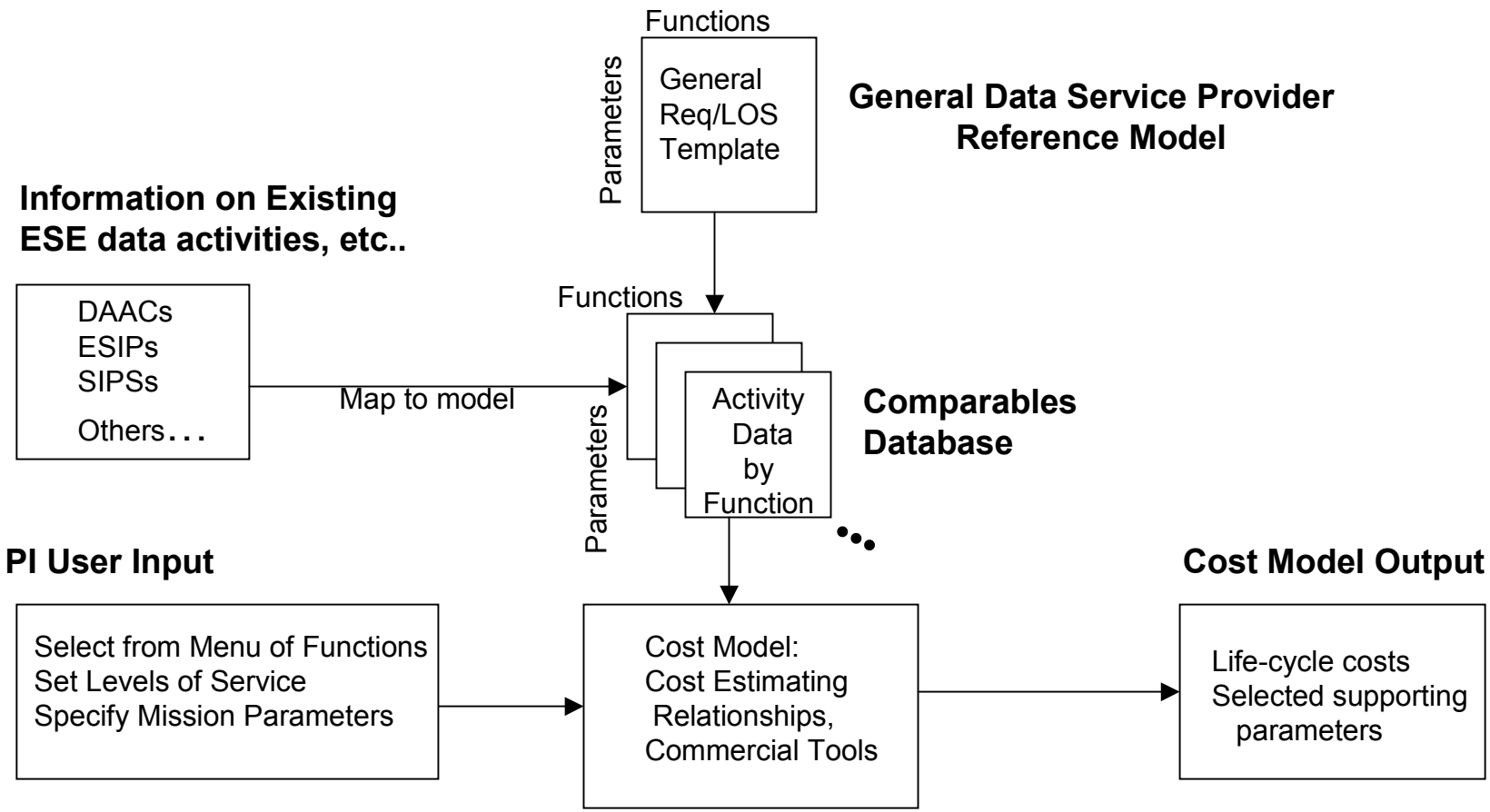
6. "Data Management and Services for Global Change Research", Don Collins

7. "SEEDS: Some Thoughts on Data Management for NASA Missions", Victor Zlotnicki

8. "Data Services", Bruce Barkstrom

Concepts: Requirements/LOS, Data Service Provider Reference Model, Cost Estimation

Principal Investigator Point of View: Single DSP



Concepts: Requirements/LOS, Data Service Provider (DSP) Reference Model, Cost Estimation.

ESE Data Services Architect Point of View:
ESE Data Services Architecture – A combination of many DSPs of different and/or multiple types.